

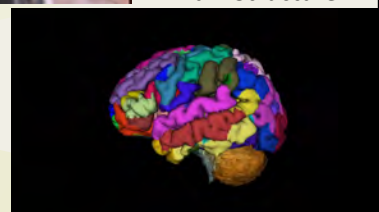
# Brain Development and Early Learning

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Brain Function

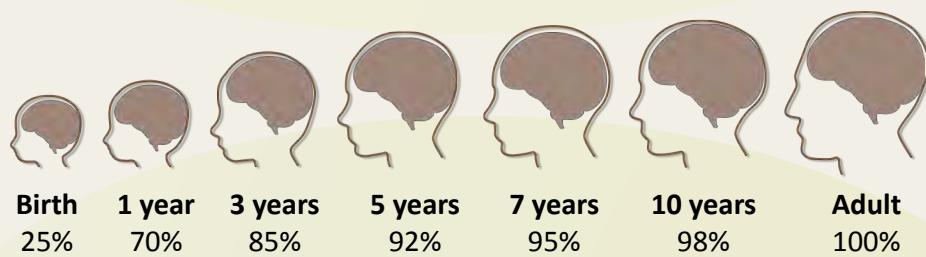
Brain Structure



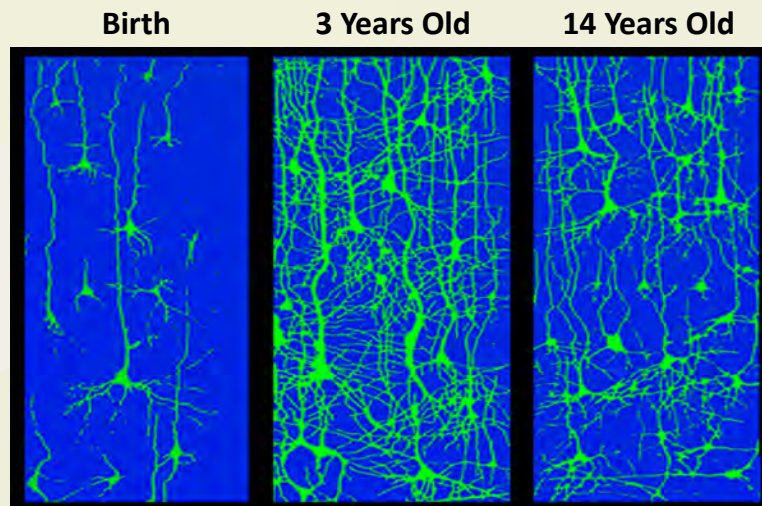
Helping  
Children and  
Families;

It's all about timing!

### Brain Growth: Birth to Adulthood

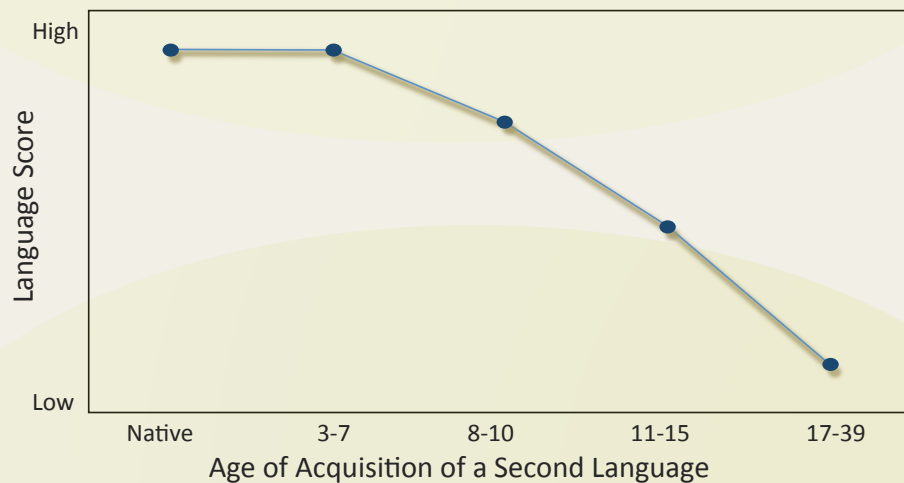


## Connections in the Brain: 86 Trillion Synapses Grow at 700/second



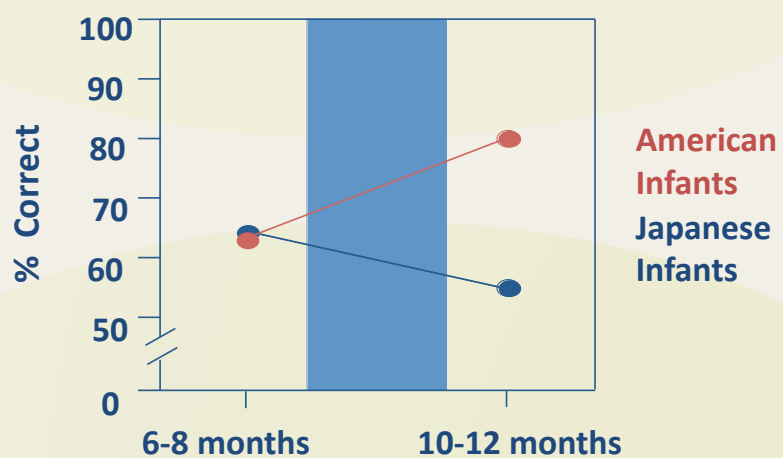
Synapses proliferate, and then are “pruned”!

## The ‘Critical Period’ for Language Learning





### The Critical Period for Sound Learning: Infant discrimination of /ra/ vs. /la/



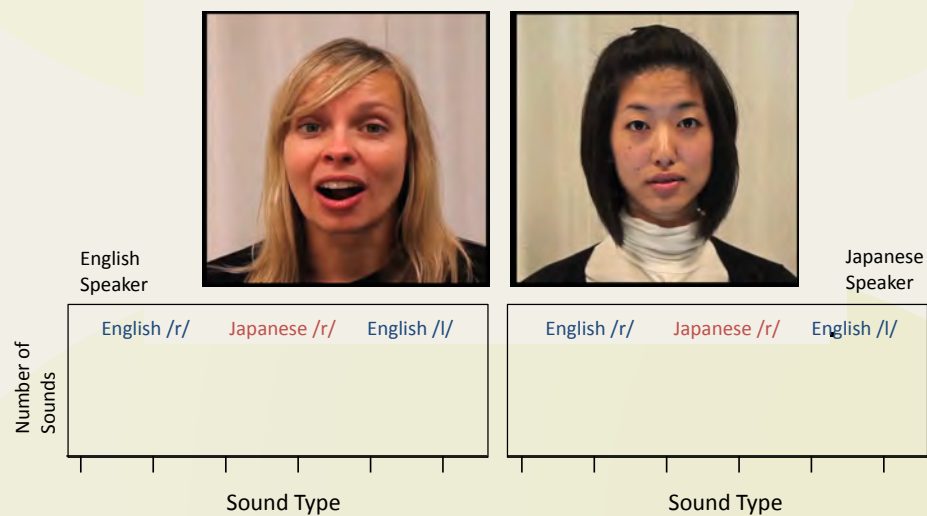
Kuhl et al., *Developmental Science*, 2006

## How do Children Learn ?

“Statistical” learning

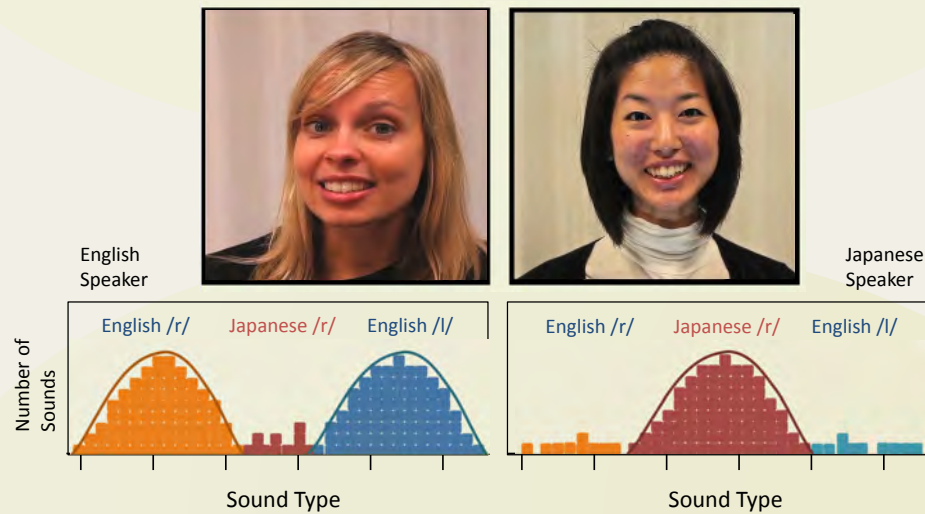
Social learning

## Infants Take Statistics



TED.com, 2011

## Infants Take Statistics



TED.com, 2011

The “social” brain ... the primary channel, not only for social and emotional learning, but also for cognitive learning in infancy





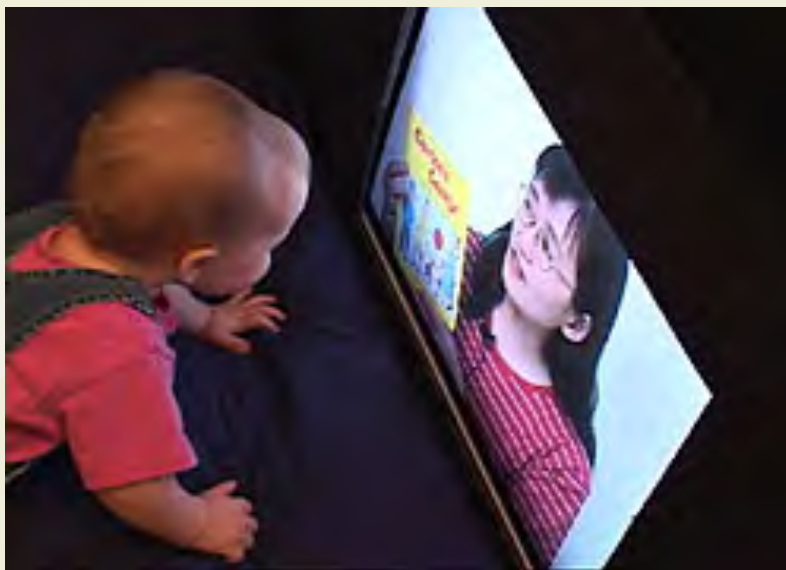
The “social” brain enables language learning!

## Second Language Learning at 9 Months of Age





## Can Infants learn language from a machine?



Kuhl, Tsao & Liu, *Proceedings of the National Academy of Science*, 2003



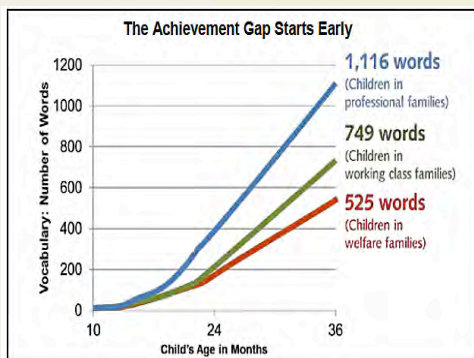
## 21<sup>st</sup> Century Family Time (in the US)



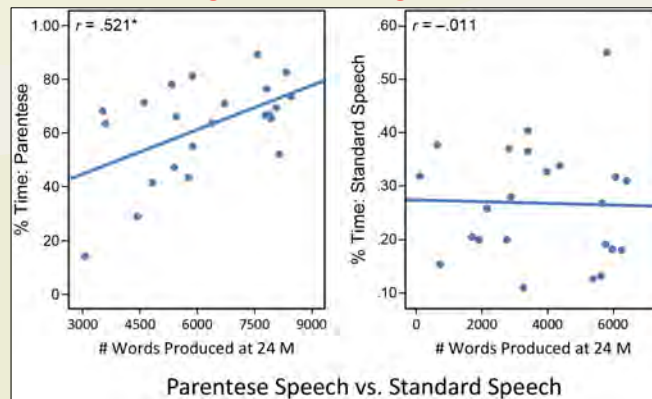
What do parents need to know?

## Talking to Children: **Quality** Matters More Than **Quantity**!

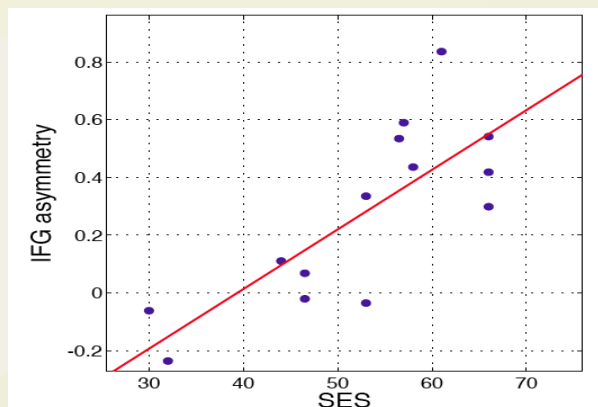
### Quantity Measures



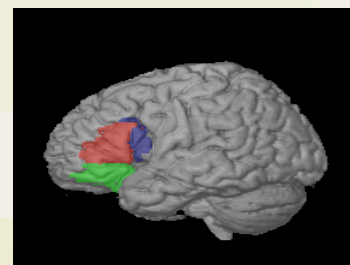
### Use of Parentese predicts language outcomes in monolingual and bilingual children



## Early learning environment and brain development



SES of the family predicts brain activation in Broca's area in 5-year-old children



Broca's area: Critical for language and social skills

Raizada, Richards, Meltzoff & Kuhl, *NeuroImage*, 2008

## Bilingualism is good for your brain!

### Bilingual Brain Development



- Equalent vocabulary growth
- Brain responses depend on language input in both languages
- Home visits to obtain rich ethnographic data

Garcia-Sierra & Kuhl, *J of Phonetics*, 2011

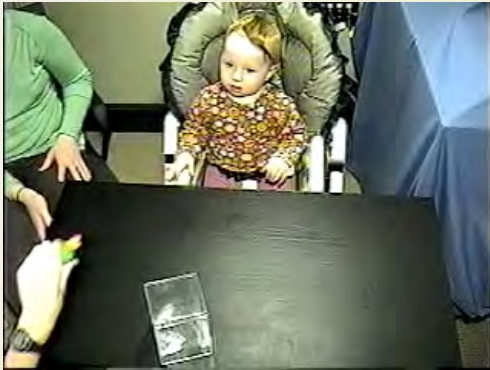
#### 4 Time Points over 8 years

Brain and behavioral measures:

- Language and cognition
- Family attitudes on learning



## Tests of Executive Function: Inhibitory Control (Monolingual child)



Conboy, Sommerville, & Kuhl (2014)

## Tests of Executive Function: Inhibitory Control (Bilingual child)



Conboy, Sommerville, Wicha, Romo & Kuhl, 2014

We will understand the mystery and magic  
of children's learning: Three examples!

## Magnetoencephalography (MEG)



## Baby MEG



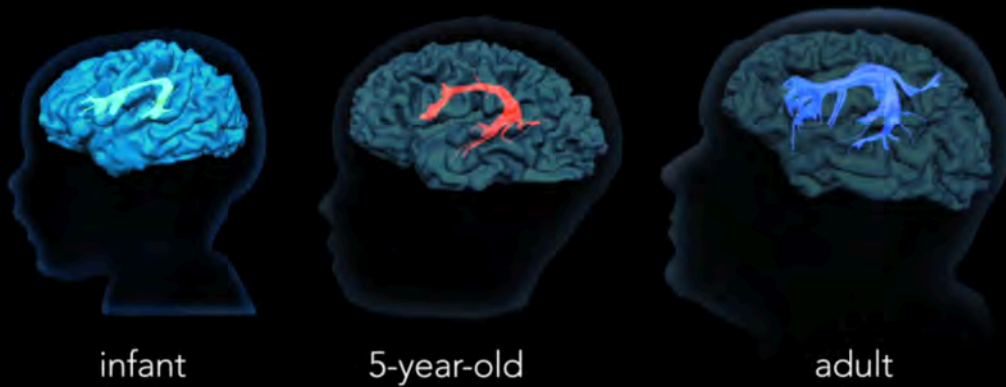
Kuhl, Ramirez, Bosseler, Lin, & Imada *Proceedings of the National Academy of Sciences*, 2014

## 12-Month Monolingual

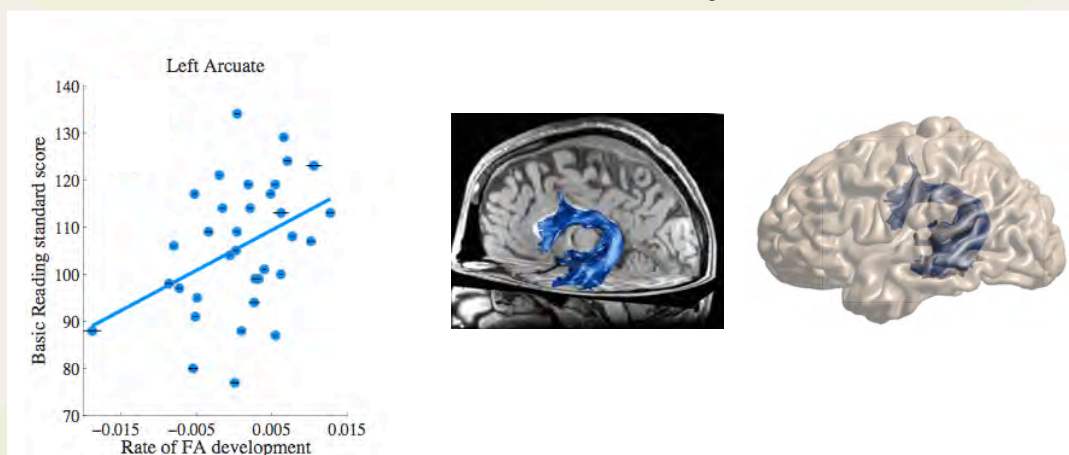




## Fiber Tract Linking Broca to Wernicke



## Timing of neural development predicts when children are “ready” to read



## Exposure to musical rhythm in infancy



- $\frac{3}{4}$  temporal rhythm
- Synchronized drum movements
- Social environment
- 12 sessions over one month's time
- Brain tests after exposure
- Tracking language development until 30 month of age

## Let's Become An Early Learning Nation!

Free on-line  
Modules from  
I-LABS!



**Thank you for listening!**

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